(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 270 277**
A1

(12) **EUROPEAN PATENT APPLICATION**

(21) Application number: **87310093.7**

(22) Date of filing: **16.11.87**

(51) Int. Cl.4: **B60H 1/22 , F23N 1/02 , F23D 11/44**

(30) Priority: **15.11.86 JP 272684/86**

(43) Date of publication of application: **08.06.88 Bulletin 88/23**

(84) Designated Contracting States: **DE GB**

(71) Applicant: **Isuzu Motors Limited**
6-22-10 Minamiooi Shinagawa-ku
Tokyo 140(JP)

(72) Inventor: **Kawamura, Hideo**
3129-13, Okada Samukawa-machi
Kouza-gun Kanagawa(JP)

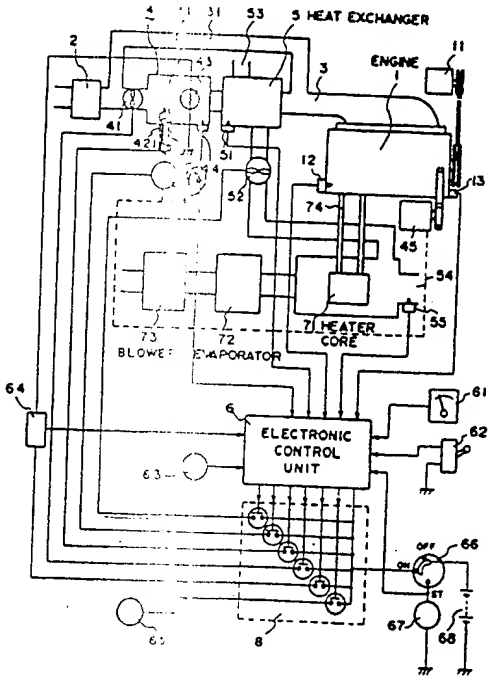
(74) Representative: **Crunner, Michael John et al**
GILL JENNINGS & EVERY 53-64 Chancery Lane
London WC2A 1HN(GB)

Heizgerät mit einer Einrichtung zur Regelung der Brennstoff-Verbrennung

(54) **Heater having a device for controlling fuel combustion therein.**

(57) A heater for the passenger compartment of a motor vehicle comprises a fuel burner (4) supplied with combustion air by a blower (41) and a heat exchanger (5) by which heat from the combustion gases from the burner (4) is transferred to heating air drawn through the heat exchanger by a blower (52). To control the combustion of the fuel in the burner (4), a flame sensor (44) having a temperature -dependent resistance wire senses the combustion conditions in the burner (4) and sends a signal, which is dependent on these conditions, to a control unit (6) which in turn controls the supply of electric power to a fuel atomizer (42) in the burner and hence controls the temperature of the atomizer. The unit (6) may also control a fuel supply valve (46), the blower (41) and an igniting glow plug (43). For this purpose it is also supplied with signals from a sensor (12) which senses the cooling water temperature of the vehicle engine (1), an engine load sensor (13), an atmospheric temperature senser (100), a temperature sensor (51) in the heat exchanger and a temperature sensor (55) which senses the temperature of the air supplied to the passenger compartment.

Fig. 1



EP 0 270 277 A1

HEATER HAVING A DEVICE FOR CONTROLLING FUEL COMBUSTION THEREIN

The present invention relates to a heater including a burner and a combustion control device for controlling fuel combustion in the burner.

The passenger compartments or cabins of motor vehicles are generally heated by a heat source employing the cooling water of the internal combustion engine of the motor vehicle. However, in cold weather, it takes time to increase the temperature of the cooling water, and hence the compartment cannot be heated quickly.

Japanese Laid-Open Patent Publication No. 61-157422 discloses a proposed vehicle heater in which fuel is combusted by a burner separate from the internal combustion engine and heat generated by the fuel combustion is recovered by a heat exchanger to supply heating air into the passenger compartment of the vehicle. In the disclosed vehicle heater, the burner has an atomizing glow plug for atomizing fuel an an igniting glow plug for igniting the atomized fuel. A controller including a bridge circuit and a comparator is employed to control electric power supplied to keep the temperatures of the atomizing glow plug and the igniting glow plug in the burner at respective predetermined temperature levels.

In the disclosed vehicle heater the temperatures of the atomizing and igniting glow plugs are controlled at their respective temperature levels, as described above. The atomizing temperature varies from fuel type to fuel type, and if the temperature of the atomizing glow plug is low when fuel of a high atomizing temperature is used, the fuel may not be sufficiently atomized, and combustion failure may result.

It is an object of the present invention to control fuel combustion in the burner of a heater by controlling the amount of heating energy in the fuel atomizer in dependence on the type of fuel used, so that fuels of different atomizing temperatures can be effectively atomized to provide good fuel combustion.

According to the present invention, a heater which includes a burner having a fuel atomizer for heating and atomizing fuel, igniting means for igniting the fuel atomized by the fuel atomizer, and a device for controlling fuel combustion in the burner, is characterised in that the control device comprises:

a flame sensor for detecting the condition of fuel combustion in said burner; and,

control means for controlling the amount of heating energy for heating fuel in said fuel atomizer in dependence upon a signal from said flame sensor.

An example of a heater in accordance with the invention will now be described with reference to the accompanying drawings, in which:-

Fig. 1 is a schematic view of the heater and its control device; and,

Figs. 2 (A) and 2 (B) together show a flowchart of a sequence of control operations performed by the control device.

As shown in Fig. 1, an internal combustion engine 1 has an intake pipe 3 serving as an air duct for introducing air from an air cleaner 2 into the engine 1. In the intake pipe 3, there are disposed a burner 4 for combusting fuel and a heat exchanger 5 positioned downstream of the burner 4 in the direction in which air flows through the intake pipe 3. The intake pipe 3 is bypassed by a bypass pipe 31 which directly introduces air from the air cleaner 2 to the internal combustion engine 1 in bypassing relation to the burner 4 and the heat exchanger 5.

A combustion blower 41 is disposed at the entrance of the burner 4 for supplying combusting air into the burner 4.

The burner 4 has a combustion chamber 41, a fuel atomizer 42 extending from the bottom of the combustion chamber 41 toward the centre of the combusiton chamber 41, and an igniting glow plug 43 disposed in the combustion chamber 41 for igniting fuel as atomized by the fuel atomizer 42.

The fuel atomizer 42 houses therein an atomizing glow plug 421 in the form of a pipe or a rod made of a ceramic material such as silicon nitride ($Si_2 No_4$) for heating and atomizing fuel. The atomizing glow plug 421 has a resistance wire of a positive temperature coefficient of resistance which is embedded centrally therein.

The igniting glow plug 43 is in the form of a rod made of a ceramic material such as silicon nitride ($Si_2 No_4$) and has a centrally embedded resistance wire of a positive temperature coefficient of resistance.

The condition of fuel combustion in the combustion chamber 41 is detected by a flame sensor 44 having a resistance wire of a temperature coefficient of resistance. The temperature of fuel combustion, i.e., the condition of fuel combustion can be detected by an electronic control unit (described later on) which reads a signal from the flame sensor 44.

Fuel is supplied to the burner 4 by a fuel pump 45 and a fuel control valve 46 through the fuel atomizer 42, and is heated and atomized by the atomizing glow plug 421. The atomized fuel is then ejected into the combustion chamber 41. The rate of supply of the fuel is controlled by a command signal from an electronic control unit 6 which con-

trols the duty cycle of the fuel control valve 46 to open and close the same. The electric current supplied to the atomizing glow plug 421 is controlled in its duty cycle by a command signal from the electronic control unit 6. The temperature to which the atomizing glow plug 421 is heated can be controlled according to the atomizing performance of the fuel.

Air introduced from an air inlet 53 into the heat exchanger 5 and heated by the heat recovered by the heat exchanger 5 is delivered by a hot air blower 52 from an air outlet 54 into the cabin of the motor vehicle. A temperature sensor 51 is attached to the heat exchanger 5 for detecting the temperature therein. A hot air temperature sensor 55 is disposed in the air outlet 54 for detecting the temperature of hot air. Signals from these temperature sensors are applied to the electronic control unit 6.

Operation with respect to the burner 4 and the heat exchanger 5 will be described below. Fuel supplied from the fuel pump 45 via the fuel control valve 46 to the fuel atomizer 42 is atomized by the atomizing glow plug 421 which has been heated by electric energization, and the atomized fuel is ejected into the burner 4. The atomized fuel is mixed with air which has been supplied from the air cleaner 2 by the blower 41 to produce a combustible air-fuel mixture. The combustible air-fuel mixture is then ignited by the energized igniting glow plug 43 into flames which turn into high-temperature combusted gasses that are delivered to the heat exchanger 5. In the heat exchanger 5, air introduced from the air inlet 53 is heated by the heat of the combusted gasses, and the heated hot air is discharged via the outlet 54 into the cabin to heat the interior thereof.

Designated at 71 is a heater core connected to the internal combustion engine 1 by a hot water passage 74, 72 an evaporator, and 73 a blower for the heater core 71. These members are components of a conventional heating and air-conditioning apparatus employing the temperature of cooling water.

Denoted at 11 is a generator driven by the engine 1, 12 a water temperature sensor for detecting the temperature of the cooling water, 13 a load sensor for detecting the load condition of the engine 1, and 63 an atmospheric temperature sensor. Detected signals from the water temperature sensor 12, the load sensor 13, and the atmospheric temperature sensor 100 are applied to the electronic control unit 6.

The electronic control unit 6 is composed of a microcomputer comprising a central processing unit for effecting arithmetic operations and counting operating time based on read signals, various memories for storing the results of arithmetic operations and a control program for efficiently controlling the burner, and input/output devices for receiving various read signals and issuing commands to the operating mechanisms. The electronic control unit 6 is connected to the flame sensor 44, the heat exchanger temperature sensor 51, the water temperature sensor 12, the hot air temperature sensor 55, the load sensor 13, a heating position switch 61, an operation switch 62, the temperature sensor 63 for detecting atmospheric temperature, a plug resistance detector 64, and others for receiving input signals from these sensors and switches. The plug resistance detector 64 is disposed in a circuit for energizing the igniting glow plug 43 and detects the temperature of the igniting glow plug 43 from the resistance value thereof which has resistance-dependent temperature characteristics by measuring the current passed through the igniting glow plug 43.

The electronic control unit 6 is also connected to a switch device 8 for controlling the various operating mechanisms and applies control commands through the switch device 8 to the hot air blower 52, the fuel pump 45, the atomizing glow plug 42, the combusting blower 41, the igniting glow plug 43, and an emergency switch 65.

Designated at 66 is a key switch, 67 a starter motor, and 68 a battery. When the key switch 66 is turned to a start position, the starter motor is energized to start the engine 1, and a start signal is applied to the electronic control unit 6.

Figs. 2(A) and 2(B) are a flowchart of an operation sequence of the control device of the present invention. Operation of the device will be described with reference to Figs. 1 and 2(A), 2(B).

The key switch 66 is turned on to supply electric power from the battery 68 to the electronic control unit 6, and the key switch 66 is further turned to the start position to energize the starter motor for thereby starting the engine 1 in a step 1. A step 2 then reads the cooling water temperature T_W from the water temperature sensor 6 and ascertains whether the cooling water temperature has reached a prescribed temperature T_1 at which the cooling water is usable for heating the compartment. If the cooling water temperature is below the temperature T_1, then control goes from the step S2 to a step S3.

The step S3 checks the resistance value R of the igniting glow plug 43 based on a signal from the plug resistance detector 64. If the resistance value R is higher than a prescribed resistance value R_1, i.e., the temperature in the burner 4 is high due to the after heat, control goes to a step S6 which reads a signal T_{AM} from the atmospheric temperature sensor 63 and checks if the atmospheric temperature signal T_{AM} is higher or lower than a prescribed temperature T_2. If the atmo-

spheric temperature T_{AM} is higher than the prescribed temperature T_2, then the igniting glow plug 43 is energized in a step 7. Since the fuel can well be ignited even if the atomizing glow plug 421 is not heated, control jumps to a step 10 without energizing the atomizing glow plug 421.

If the resistance value R of the igniting glow plug 43 is lower than R_1 in the step 3, the igniting glow plug 43 is energized in a step 4 since it is presumed that the temperature in the combustion chamber 41 is low, and the atomizing glow plug 421 is normally energized and heated in a step 5.

If the atmospheric temperature T_{AM} is lower than the prescribed temperature T_2 in the step 6, then control goes to a step 8 in which the igniting glow plug 43 is turned on, and then the atomizing glow plug 421 is normally energized in a step 9. Therefore, fuel can sufficiently be atomized even if the temperature of combusting air is low.

In steps 10, 11, the fuel control valve 46 is opened to supply fuel into the burner 4 through the atomizing glow plug 421, and the combusting blower 41 is driven to force combusting air into the burner 4. A step 12 ascertains whether the key switch 66 is in the start position or not. If the key switch 66 is in the start position in the step 12, then the engine load condition is checked by the load sensor 13 in a step 13. If the engine load L is lower than a prescribed load level La in the step 13, the heating position is checked in a step 14. If the heating position switch 61 is turned on, a step 15 ascertains whether the heat exchanger temperature T_{HE} as detected by the heat exchanger temperature sensor 51 is higher than a prescribed temperature T_5. If the heat exchanger temperature T_{HE} is higher than the prescribed temperature T_5, then control goes to a step 16 in which the hot air blower 52 is energized to start supplying air. If the key switch 66 is not in the start position in the step 12, if the engine load is higher than the load level La in the step 13, if the heating position switch 61 is turned off in the step 14, or if the heat exchanger temperature is lower in the step 15, then control goes to a flow for stopping the operation of the burner.

After the hot air blower 52 has been operated in the step 16, the operating time of the burner is counted in a step 17. A step 18 then checks a signal T_{FS} from the flame sensor 44 on the burner 4. If the burner temperature is higher than a prescribed temperature T, then control goes to a step 23 since the combustion condition is good. If lower than the temperature T, then control proceeds to a step 19 in which a prescribed operating time is set to N. If the operating time N is 3N or more in a step 20, then an failure signal is generated to issue a signal to turn off the emergency switch 65 (steps 21, 22).

If the time ts in which the burner 4 operates to burn the fuel is longer than a prescribed time t in the step 23, then control goes to a step 24 as it is assumed that the combustion condition is stable. If the time ts has not reached the time t, then the fuel pump 45 is controlled to supply fuel in the step 24, and the combusting blower 41 is controlled to supply air for combustion in a step 25 to activate the combustion in the burner 4. These operations are calculated and a signal R_F from the flame sensor 44 is checked (steps 26, 27). The signal R_F from the flame sensor 44 which corresponds to the temperature in the burner 4 is compared with a prescribed temperaure R_0. If the signal R_F is higher than R_0, then control proceeds to a step 28 in which the atomizing glow plug 421 is turned off to because the combustion in the combustion chamber 41 is active and the fuel can easily be atomized. If the signal R_F is lower than R_0, control goes a step 29 in which the atomizing glow plug 421 is energized to assist in atomizing the fuel for activating fuel combustion. A next step 30 compares the signal R_F from the flame sensor 44 with the prescribed temperature R_0. If $R_F > R_0$, i.e., the temperature R_F in the combustion chamber 41 is higher than the prescribed temperature R_0, then control goes to a step 34. If the temperature R_F is lower than R_0 because of an atomization failure due to a high atomizing temperature of fuel having different atomizing performance, then electric power supplied to the atomizing glow plug 42 is increased, the signal R_F is checked, and a failure signal is generated if the condition $R_F > R_0$ is not reached (steps 30, 31, 32, 33).

In the step 34, a signal from the heating position switch 61 which has been set to a desired heating temperature is read. If the heating position switch 61 is in the first position, then the fuel control valve 46 is controlled at a first flow rate in a step 35. If the heating position switch 61 is in the second position, then the hot air blower 52, the combusting blower 41, and the fuel control valve 46 are controlled at a second flow rate to increase the fuel and air supply to the burner 4 and also the hot air discharged from the heat exchanger 5 for thereby increasing the temperature in the vehicle cabin (steps 36 through 39).

If the heating position switch 61 is in the third position in the step 36, then the hot air blower 52, the combusting blower 41, and the fuel control valve 46 are controlled by the switch device 8 at a third flow rate to discharge hot air via the outlet 54 into the cabin in maximum operation (steps 40 through 42).

If the temperature T_A of the discharged hot air is higher than prescribed hot air temperatures T_4 corresponding respectively to the first, second, and

third fuel rates in a step [redacted] then control goes to steps 44, 45, 46 in which [redacted]ation of the combusting blower 41, the hot air blower 52, and the fuel pump 45 is temporarily interrupted, and then control returns to the step 2. Then, the above flow is repeated.

In the above embodiment, as described above, the combustion condition in the combustion chamber 41 of the burner 4 is checked according to the electric resistance of the flame sensor 44 in the combustion chamber 41 while the heater is in operation. Based on the detected combustion condition, the supply of electric power to the atomizing glow plug 421 of the fuel atomizer 42 is controlled in order to allow the fuel to be well atomized and combusted. Therefore, even if fuel of a type which can be atomized in a different condition is used, the fuel can well be combusted since atomizing assistance is adjusted accordingto the combustion condition of the fuel.

Claims

1. A heater including a burner (4) having a fuel atomizer (42) for heating and atomizing fuel, igniting means (43) for igniting the fuel atomized by the atomizer, and a device for controlling fuel combustion in the burner, characterised in that the control device comprises:

a flame sensor (44) for detecting the condition of fuel combustion in said burner (4); and,

control means (6,8) for controlling the amount of heating energy for heating fuel in said fuel atomizer (42) in dependence upon a signal from said flame sensor.

2. A heater according to claim 1, wherein said fuel atomizer (42) has a glow plug (421) which is heated by being energized.

3. A heater according to claim 2, wherein said glow plug (421) includes a resistive body having a positive temperature coefficient of resistance.

4. A heater according to claim 2, wherein said glow plug (421) comprises a body made of a ceramic material and a resistive member embedded in said body.

5. A heater according to any one of the preceding claims wherein said flame sensor (44) comprises a resistive body having a temperature-dependant resistance.

Fig. 1

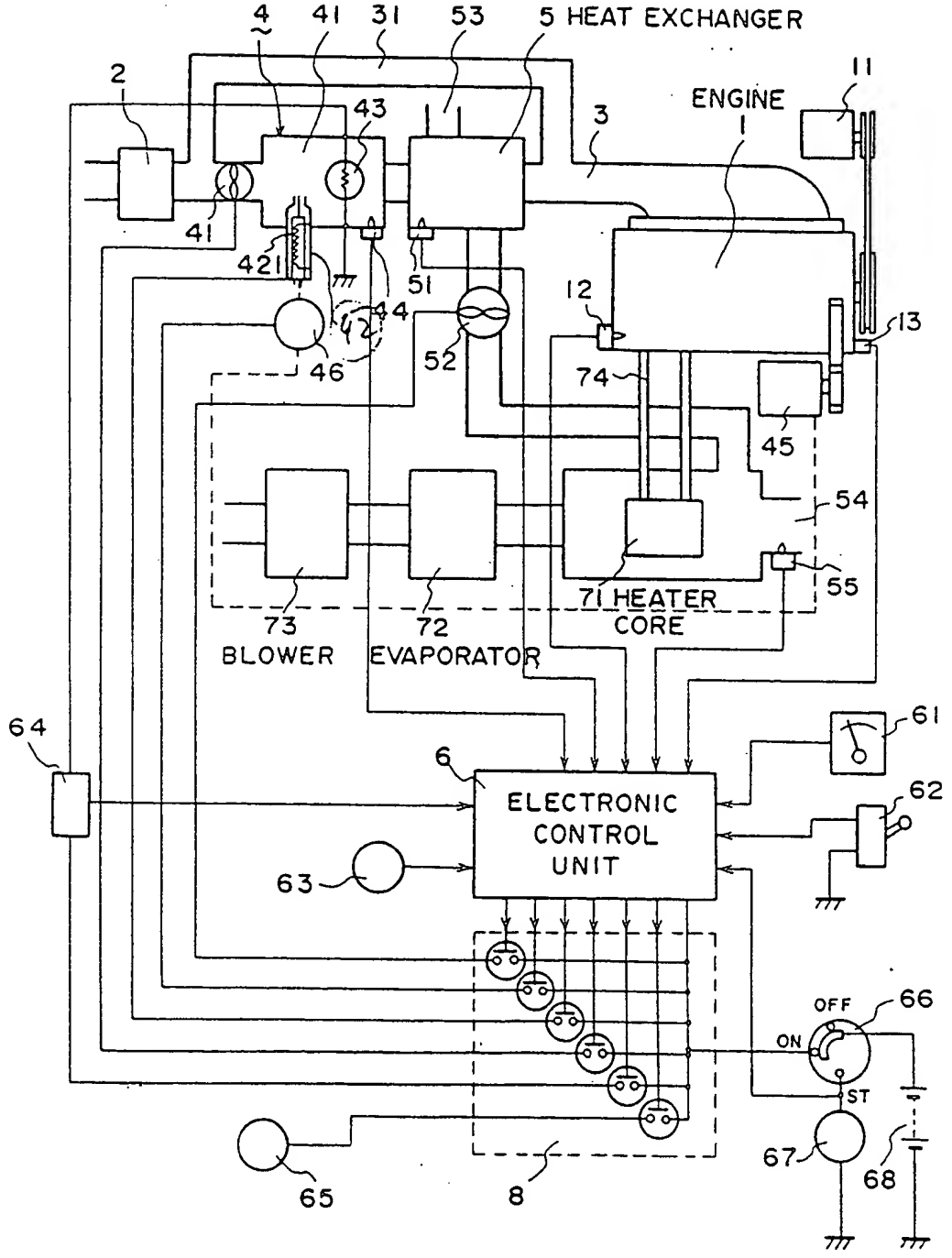

4
41
31
53
5 HEAT EXCHANGER
2
43
3
ENGINE
11
1
41
421
51
12
13
42
44
46
52
74
45
54
55
71 HEATER CORE
73 BLOWER
72 EVAPORATOR
64
61
6
ELECTRONIC CONTROL UNIT
62
63
OFF
66
ON
ST
67
68
65
8

Fig. 2 (A)

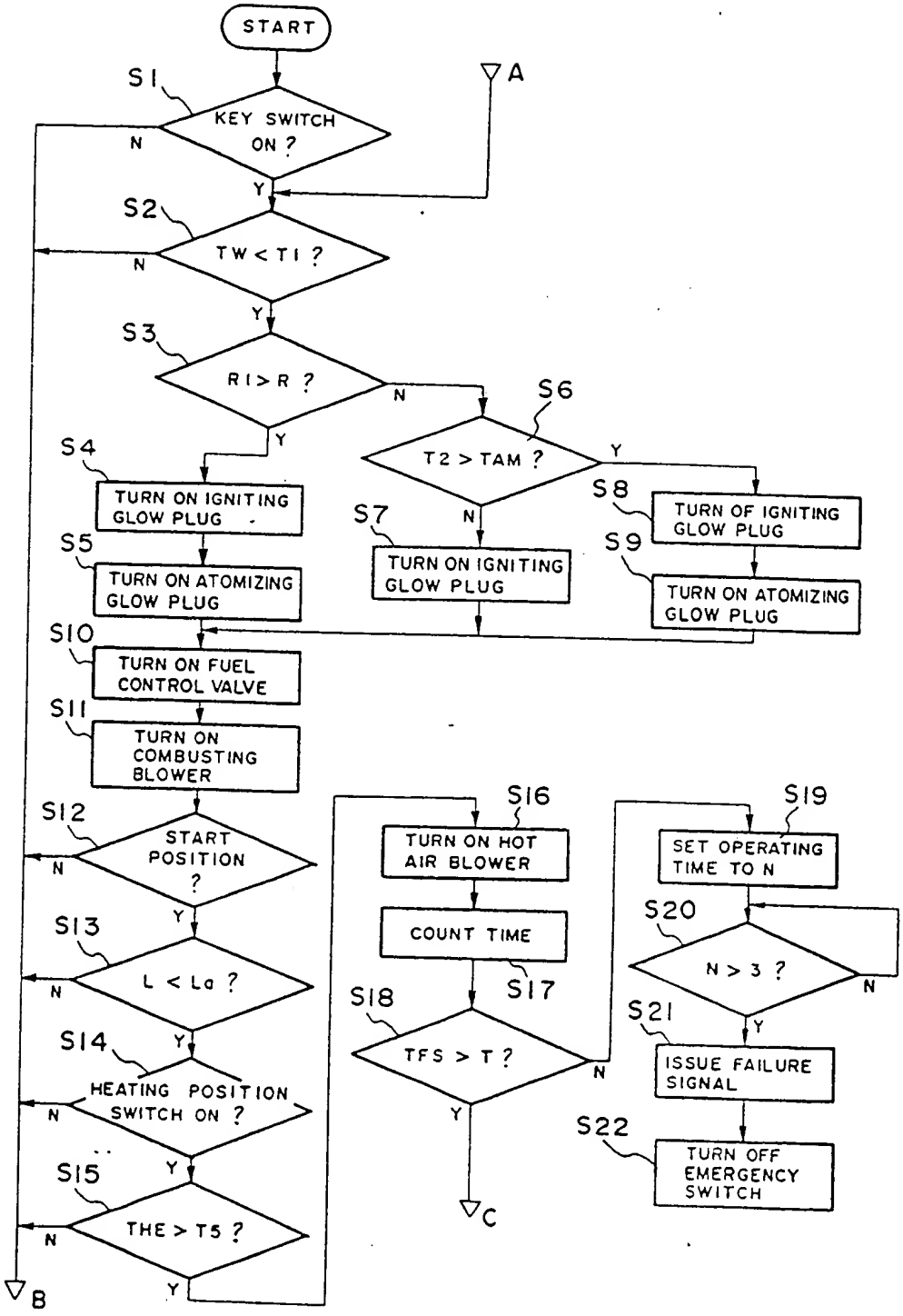
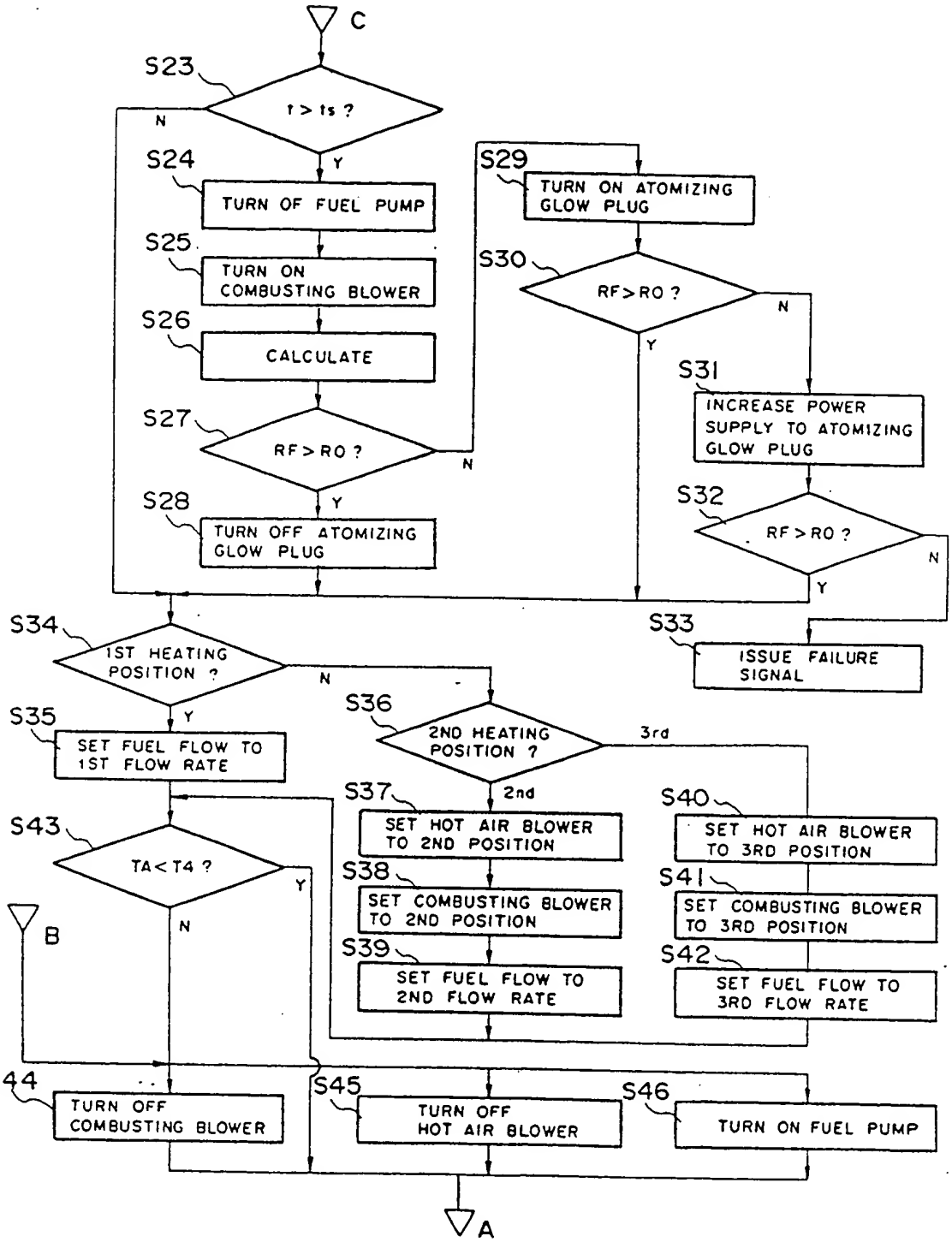

START
S1
KEY SWITCH ON ?
N
Y
A
S2
TW < T1 ?
N
Y
S3
R1 > R ?
N
Y
S6
T2 > TAM ?
Y
N
S4
TURN ON IGNITING GLOW PLUG
S5
TURN ON ATOMIZING GLOW PLUG
S7
TURN ON IGNITING GLOW PLUG
S8
TURN OF IGNITING GLOW PLUG
S9
TURN ON ATOMIZING GLOW PLUG
S10
TURN ON FUEL CONTROL VALVE
S11
TURN ON COMBUSTING BLOWER
S12
START POSITION ?
N
Y
S13
L < Lo ?
N
Y
S14
HEATING POSITION SWITCH ON ?
N
Y
S15
THE > T5 ?
N
Y
B
S16
TURN ON HOT AIR BLOWER
COUNT TIME
S17
S18
TFS > T ?
N
Y
C
S19
SET OPERATING TIME TO N
S20
N > 3 ?
N
Y
S21
ISSUE FAILURE SIGNAL
S22
TURN OFF EMERGENCY SWITCH

Fig.2 (B)



European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 87 31 0093

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
Y	GB-A-2 130 710 (DANFOSS A/S) * Figures 1,2; abstract; page 4, lines 19-94 *	1,2	B 60 H 1/22 F 23 N 1/02 F 23 D 11/44
Y,D	PATENT ABSTRACTS OF JAPAN, vol. 10, no. 360 (M-541)[2417], 3rd December 1986; & JP-A-61 157 422 (ISUZU MOTORS LTD) 17-07-1986	1,2	
A	PATENT ABSTRACTS OF JAPAN, vol. 10, no. 270 (M-517)[2326], 13th September 1986; & JP-A-61 92 911 (ISUZU MOTORS LTD) 10-05-1986		
A	PATENT ABSTRACTS OF JAPAN, vol. 10, no. 134 (M-479)[2191], 17th May 1986; & JP-A-60 259 808 (TOUSHIBA NETSUKIGU K.K.) 21-12-1985		

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

F 23 N
F 23 D
B 60 H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	15-02-1988	THIBO F.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P0401)